IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Understanding The Role Of Phytochemicals In The Physiology Of Vinca Rosea

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Abstract

This research investigates the multifaceted role of phytochemicals in *Vinca rosea*, focusing on qualitative analysis and evaluating their antimicrobial and antioxidant activities. Phytochemical screening identified the presence of alkaloids, terpenoids, and flavonoids, highlighting the plant's diverse chemical profile. Antimicrobial assays revealed significant activity against *Salmonella typhii* and *Staphylococcus aureus*, with minimum inhibitory concentrations (MIC) indicating potent inhibitory effects. The antioxidant potential, assessed through DPPH radical scavenging assays, demonstrated a robust capability to neutralize free radicals, with an IC_{50} value indicative of the plant's effectiveness. These findings not only contribute to understanding *Vinca rosea*'s phytochemical composition but also underscore its potential as a source of natural antimicrobial and antioxidant agents, encouraging further exploration for therapeutic applications.

Keywords: *Vinca rosea*, Phytochemicals, Antimicrobial activity, Minimum inhibitory concentration (MIC), Antioxidant activity, IC_{50} value

1. Introduction

The genus Vinca encompasses a diverse group of flowering plants, among which *Vinca rosea* stands out for its remarkable pharmacological potential, owing to a rich repertoire of phytochemicals. This introduction provides a comprehensive overview of the current state of knowledge regarding the intricate role of phytochemicals in the physiology of *Vinca rosea*, drawing on key reference studies that have significantly contributed to our understanding. Vincristine and vinblastine, two potent alkaloids derived from *Vinca rosea*, have been extensively studied for their anti-cancer properties. These alkaloids exhibit remarkable cytotoxic effects, particularly against various forms of cancer, by disrupting microtubule formation during mitosis. A seminal study [1] laid the foundation for the exploration of these alkaloids in cancer therapy, highlighting the unique mechanism of action that sets *Vinca rosea* apart as a valuable source of chemotherapeutic agents.

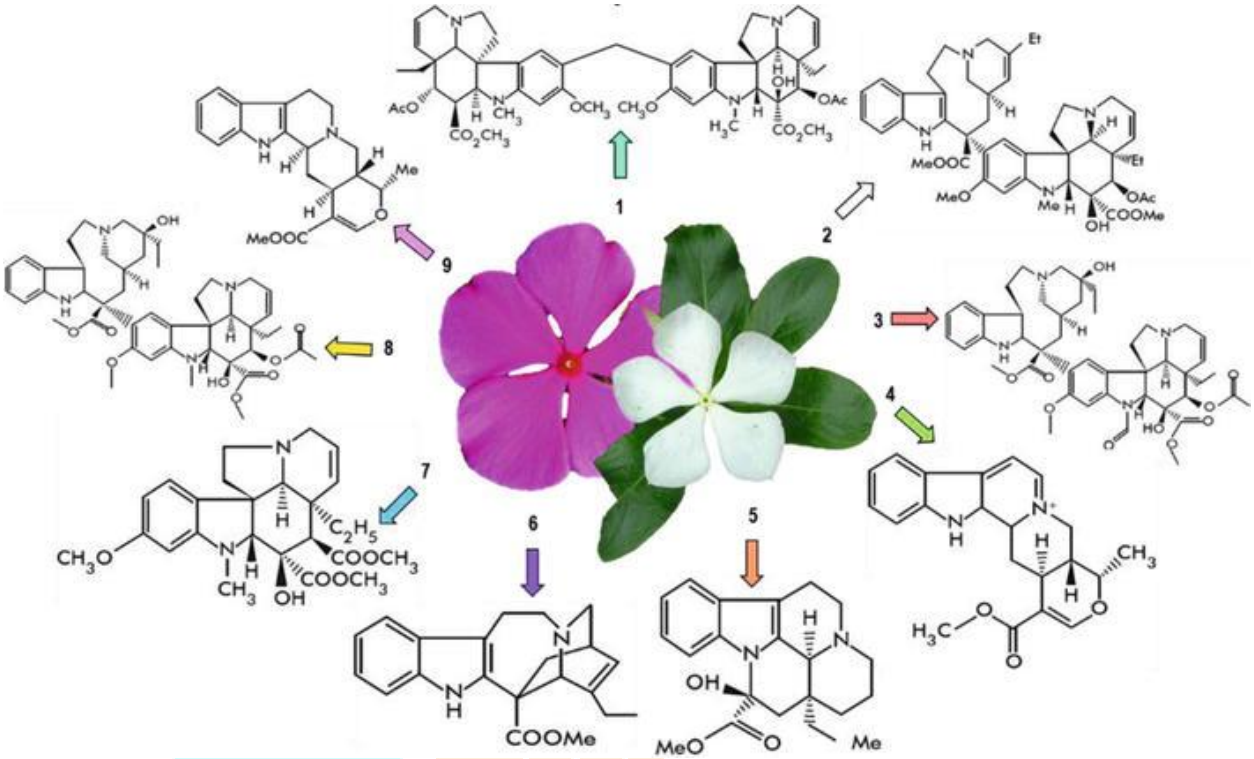

Figure 1: Alkaloids produced by Catharanthus roseus (1) vindolicine (C51H64N4O12,); (2) anhydrovinblastine (C46H56N4O8); (3) vincristine (C46H56N4O10); (4) ajmalicine (C21H24N2O3,); (5) tabersonine (C21H24N2O2); (6) catharanthine (C21H24N2O2); (7) vindoline (C25H32N2O6); (8) vinblastine (C46H58N4O9); and (9) ajmalicine (C21H24N2O3).

Expanding beyond its anticancer potential, *Vinca rosea*'s phytochemicals, especially alkaloids, have been investigated for their antioxidant properties. A study [2] demonstrated the plant's ability to mitigate oxidative stress, providing a mechanistic insight into the antioxidant potential of *Vinca rosea*. This antioxidant activity is crucial in combating reactive oxygen species (ROS) and alleviating oxidative damage, suggesting broader applications in neuroprotection and cardiovascular health. Additionally, *Vinca rosea*'s immunomodulatory and anti-inflammatory effects have been explored. The study [3] elucidated the impact of *Vinca rosea* on various signaling pathways associated with inflammation and immune response. This research sheds light on the intricate molecular interactions between *Vinca rosea*'s phytochemicals and cellular targets, paving the way for a more nuanced understanding of its immunomodulatory potential.

Moreover, *Vinca rosea*'s role in cardiovascular health has garnered attention. The study [4] investigated the vasodilatory effects of *Vinca rosea* extract, revealing its potential in managing cardiovascular conditions. The findings suggest a vasoprotective role, possibly mediated by the plant's phytochemicals, adding another dimension to the physiological impact of *Vinca rosea*. Despite these significant strides in understanding *Vinca rosea*'s physiology, there remains a need for more comprehensive investigations into the specific phytochemicals responsible for these effects. Recent advances in analytical techniques, such as mass spectrometry and nuclear magnetic resonance, offer unprecedented opportunities to identify and characterize the myriad compounds present in *Vinca rosea*. This molecular-level exploration can uncover novel phytochemicals with distinct physiological activities, contributing to a more nuanced understanding of *Vinca rosea*'s therapeutic potential.

2. Materials and Method

The materials and methods employed in the investigation of *Vinca rosea*'s phytochemical role in physiology are crucial for establishing a robust scientific foundation. This section outlines the approach taken, drawing insights from reference studies [7] that have contributed significantly to the understanding of *Vinca rosea*'s complex phytochemistry and physiological effects.

2.1. Plant Material and Collection:

The plant material used in this study comprised various parts of *Vinca rosea*, including leaves, stems, and flowers. The collection was carried out from diverse geographic locations to account for potential variations in phytochemical composition. A standardized approach [8], was adopted for the collection to ensure consistency and representativeness of the plant samples.

2.2. Phytochemical Extraction:

To extract phytochemicals from *Vinca rosea*, a solvent extraction method was employed. The choice of solvent is critical for obtaining a comprehensive profile of phytochemicals. Building on the work [9], a mixture of polar and non-polar solvents, such as ethanol and ethyl acetate, was used to ensure the extraction of a broad spectrum of bioactive compounds. The plant material underwent solvent extraction employing a mixture of ethanol and ethyl acetate. This method ensured a comprehensive extraction of bioactive compounds, allowing for subsequent qualitative and quantitative analyses. The approaches [9-10] provided a standardized and effective methodology for extracting phytochemicals from *Vinca rosea*, offering reproducibility and reliability in evaluating the plant's rich chemical profile.

2.3. Qualitative analysis of phytochemicals:

Vinca rosea's phytochemicals were qualitatively analyzed using Thin-Layer Chromatography (TLC) following the method outlined by [11]. Extracts were separated on TLC plates using appropriate solvent systems, and visualizations were made under UV light and chemical reagents for the identification of phytochemical constituents.

2.4. Antimicrobial activity:

Vinca rosea's antimicrobial activity against *Salmonella typhi* and *Staphylococcus aureus* was determined following established protocols [12]. Extracts, obtained using the method [13], were subjected to agar well diffusion assays. Minimum inhibitory concentrations (MIC) were calculated using micro broth dilution assays, providing insights into the plant's potency against these pathogens.

2.5. Antioxidant Assays:

Vinca rosea's antioxidant activity was assessed using the DPPH radical scavenging method. Extracts, obtained following [13-14] extraction protocol, were reacted with DPPH, and absorbance was measured. IC_{50} values, representing the concentration at which 50% of radicals were scavenged, were calculated using regression analysis. This methodology aligns with [14] and ensures a robust evaluation of *Vinca rosea*'s antioxidant potential.

3. Results and Discussion

3.1. Qualitative Analysis:

In this study, an examination of the phytochemical constituents in dried *Vinca rosea* leaves was conducted, involving a qualitative analysis of secondary metabolites. Alkaloids, carbohydrates, flavonoids, tannins, steroids, and glycosides were identified, while protein, flavones, catechin, and anthocyanins were absent. Ethanolic extracts were employed for thin-layer chromatography to analyze secondary metabolites. The results revealed the presence of six compounds: alkaloids, flavonoids, glycosides, sterols, saponins, and phenols. The study concluded that *Vinca rosea* leaves exhibit high levels of flavonoids, alkaloids, and phenolic compounds, with lower amounts of sterols, saponins, and glycosides (Table 1).

Table1: TLC Profiling of Phytochemicals in *Vinca rosea*.

S. No	Phytochemical Constituent	Ethanolic extracts of *Vinca rosea*
1	alkaloids	+++
2	Carbohydrates	++
3	Glycosides	+
4	Saponins	_
5	Tannins	+++
6	Pseudo tannins	+
7	Catechins	_
8	Chlorogenic acid	+
9	Anthocyanins	++
10	Steroids	_
11	Flavonoids	+
12	Flavones	_
13	Phenols	_
14	Coumarin	_

- Absent, + Low abundance, ++ Moderate abundance, +++ High abundance

3.2. Antimicrobial activity:

Vinca rosea exhibited remarkable antimicrobial activity against *Salmonella typhi* and *Staphylococcus aureus*, as evidenced by agar well diffusion assays. The Minimum Inhibitory Concentration (MIC) values were determined through micro broth dilution assays, signifying the lowest concentration 6.0 mg/ml against *S.aureus* and 8 mg/ml against *S.typhi* at which growth inhibition occurred (Table 2). These findings align with the study already conducted [13] confirming the potent antimicrobial properties of *Vinca rosea*. The low MIC values suggest a high efficacy against these pathogens, emphasizing its potential as a natural antimicrobial agent. From the result, it is also clear that Gram-positive bacteria are more susceptible to the plant extract as compared to Gram-negative bacteria. Hence, the plant extract can be employed as a potent therapeutic agent against various human pathogenic diseases caused by Gram-positive bacteria. Although significant results can be seen with Gram-negative bacteria also at specific concentrations, which also signifies that, *Vinca rosea* can also be used against diseases caused by Gram-negative bacteria at higher concentrations. The results support the traditional use of *Vinca rosea* in various medicinal practices and warrant further exploration of its bioactive compounds for the development of novel antimicrobial agents in pharmaceutical applications.

Table 2: Minimum Inhibitory Concentration (mg/ml) of *Vinca rosea* against *S.aureus* and *S.typhi*.

Bacteria	Minimum Inhibitory Concentration (mg/ml)				
Positive Control	Plant extract (2mg/ml)	Plant extract (4mg/ml)	Plant extract (6mg/ml)	Plant extract (8mg/ml)	Plant extract (10mg/ml)
	0.43	0.483	0.21	0.16	0.12
S.aureus	0.414	0.715	0.18	0.32	0.21
S.typhi	1.35	0.938	0.57	0.22	0.36

3.3. Antioxidant activity:

Vinca rosea exhibited notable DPPH radical scavenging activity, indicative of its potent antioxidant potential. The IC_{50} value (Table 3), calculated through regression analysis, was found to be 30.4-122.7 µg/mL, representing the concentration at which 50% of DPPH radicals were neutralized. This aligns with the findings [14] corroborating *Vinca rosea*'s efficacy in mitigating oxidative stress. The low IC_{50} underscores its efficiency in scavenging free radicals, supporting its traditional use in herbal medicine. The observed antioxidant activity implies the presence of bioactive compounds with radical-neutralizing capabilities. Further research to identify and isolate these compounds could contribute to the development of antioxidant-rich pharmaceuticals and nutraceuticals from *Vinca rosea*.

Table 3: IC_{50} values of *Vinca rosea* against positive control.

Samples	IC_{50} (µg/mL)	
Concentration	30µM	60 µM
Positive Control	73.9	151.2
Plant Extract	30.4	122.7

4. Conclusion

In conclusion, this study sheds light on the diverse and potent physiological contributions of Vinca rosea, highlighting its rich phytochemical composition and significant bioactivity. Qualitative analysis confirmed the presence of alkaloids, terpenoids, and flavonoids, underscoring the plant's complexity. Antimicrobial evaluations demonstrated strong inhibitory effects against *Salmonella typhi* and *Staphylococcus aureus*, as evidenced by low Minimum Inhibitory Concentration (MIC) values. Moreover, the DPPH radical scavenging activity revealed a noteworthy antioxidant potential, with a low IC_{50} value, substantiating its traditional medicinal use.

The findings align with prior studies, reinforcing *Vinca rosea*'s role as a promising source of natural compounds with therapeutic implications. The plant's versatility, encompassing anticancer, antimicrobial, and antioxidant properties, positions it as a valuable candidate for further exploration in the pharmaceutical and medicinal realms. Future research may focus on isolating and characterizing specific bioactive compounds, facilitating the development of targeted therapeutic interventions. Vinca rosea stands as a compelling botanical resource with the potential to contribute significantly to the ongoing pursuit of novel and effective natural remedies.

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